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(54) **JOINT BODIES AND METHODS FOR COVERING ELECTRICAL CABLES AND CONNECTIONS**

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(58) **Field of Classification Search**

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See application file for complete search history.

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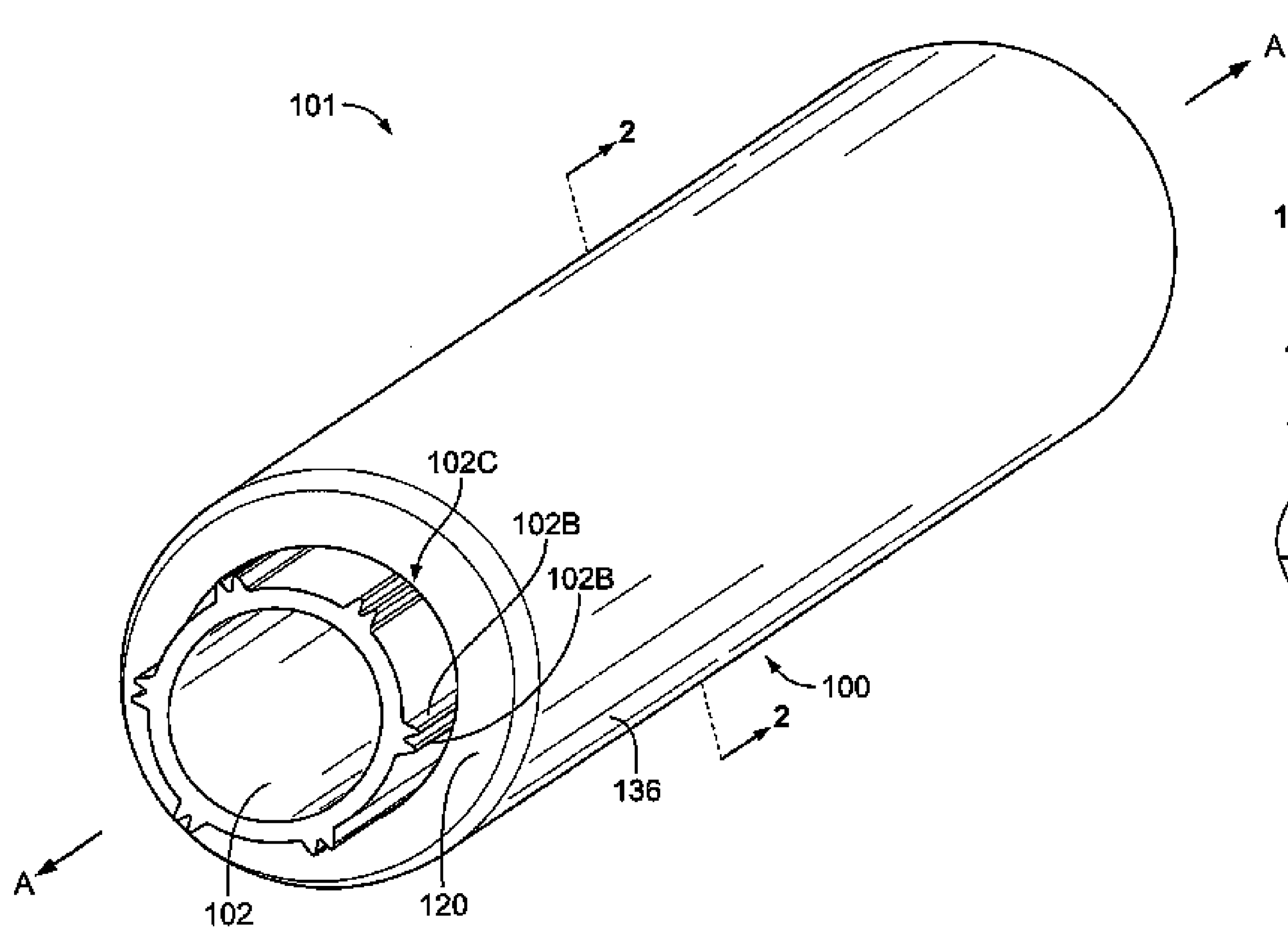
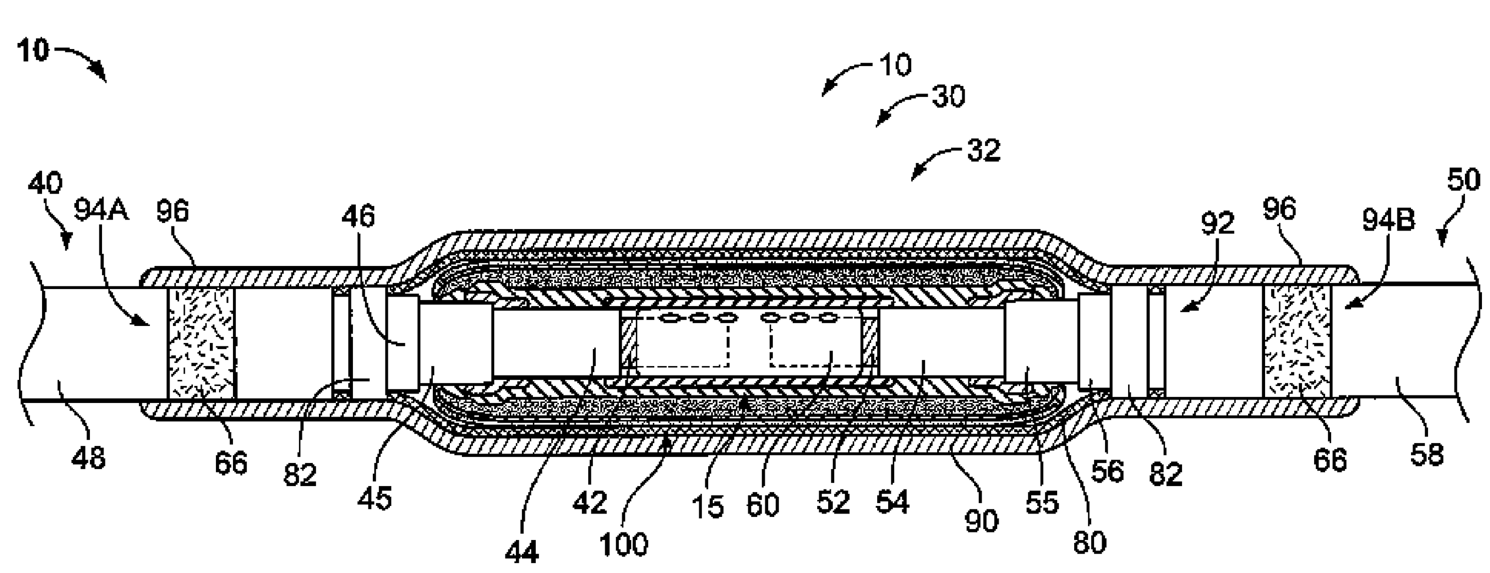
(57) **ABSTRACT**

A joint body for protecting an electrical cable connection including an electrical cable includes an expandable, elastomeric bladder sleeve and an electrically insulating gel. The bladder sleeve defines a gel cavity and a cable passage to receive the electrical cable. The gel is disposed in the gel cavity and surrounds at least a portion of the cable passage. The joint body is configured to be installed on the connection such that the connection is disposed in the cable passage and is surrounded and electrically insulated by the gel.

23 Claims, 10 Drawing Sheets





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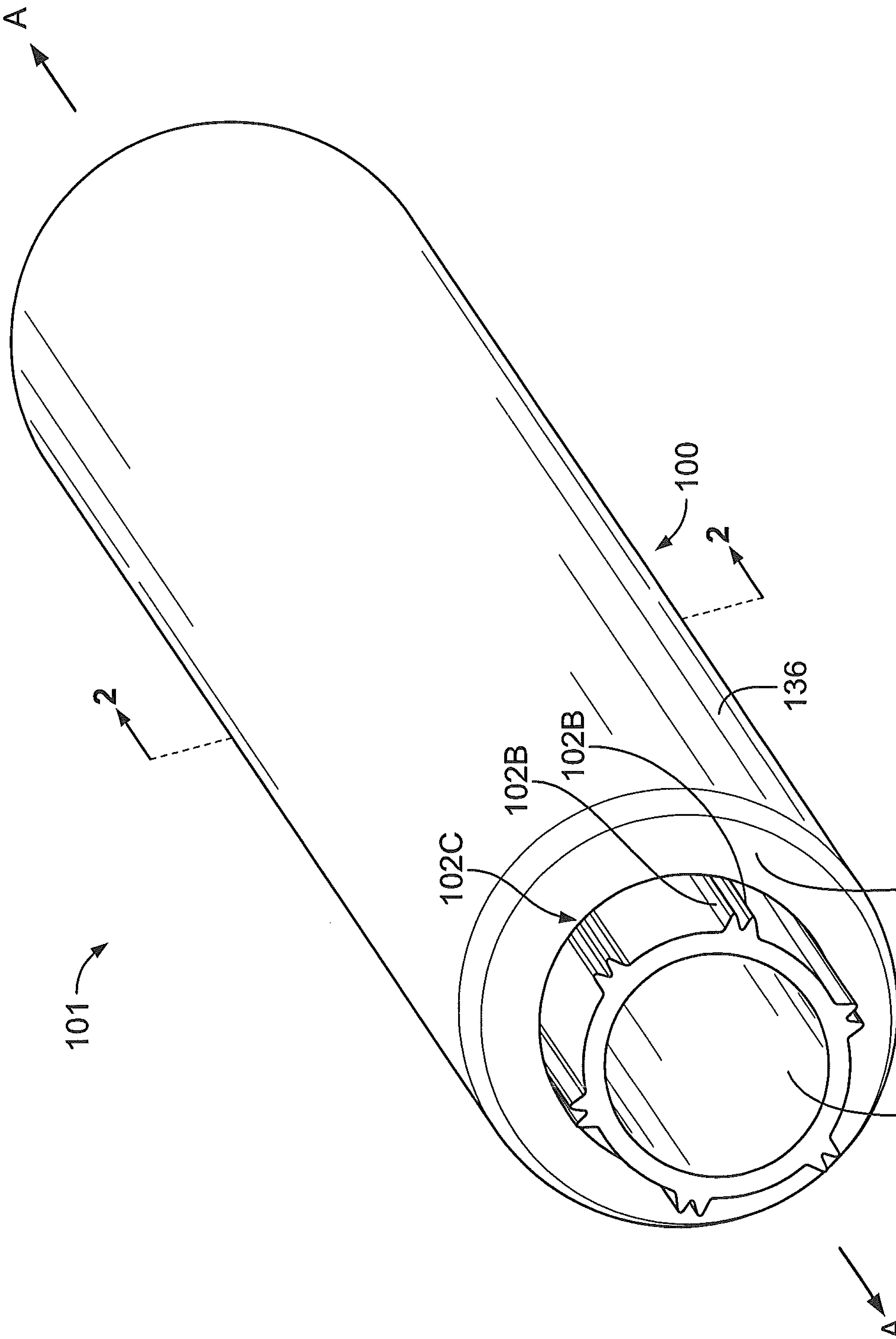


FIG. 1

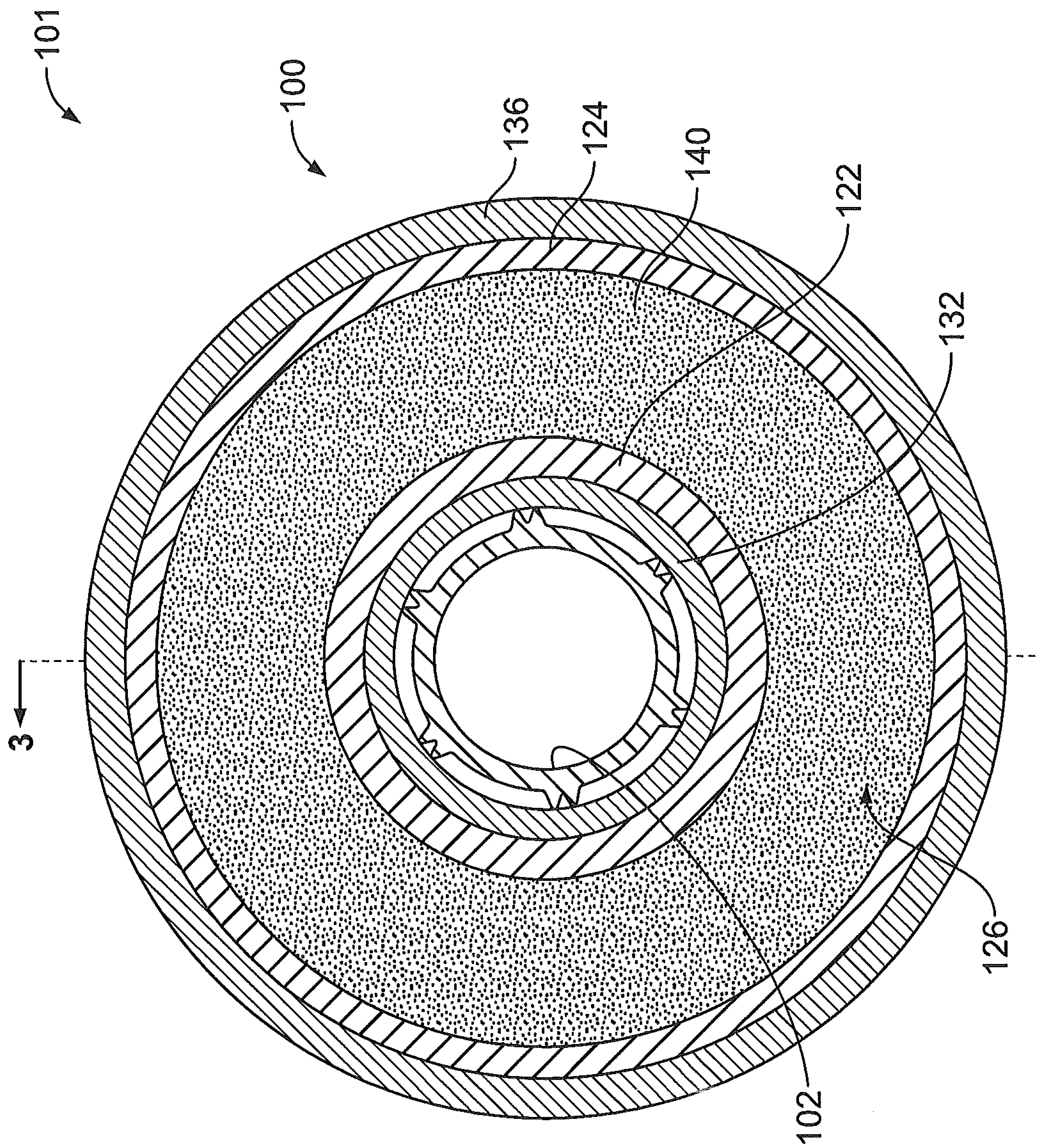


FIG. 2

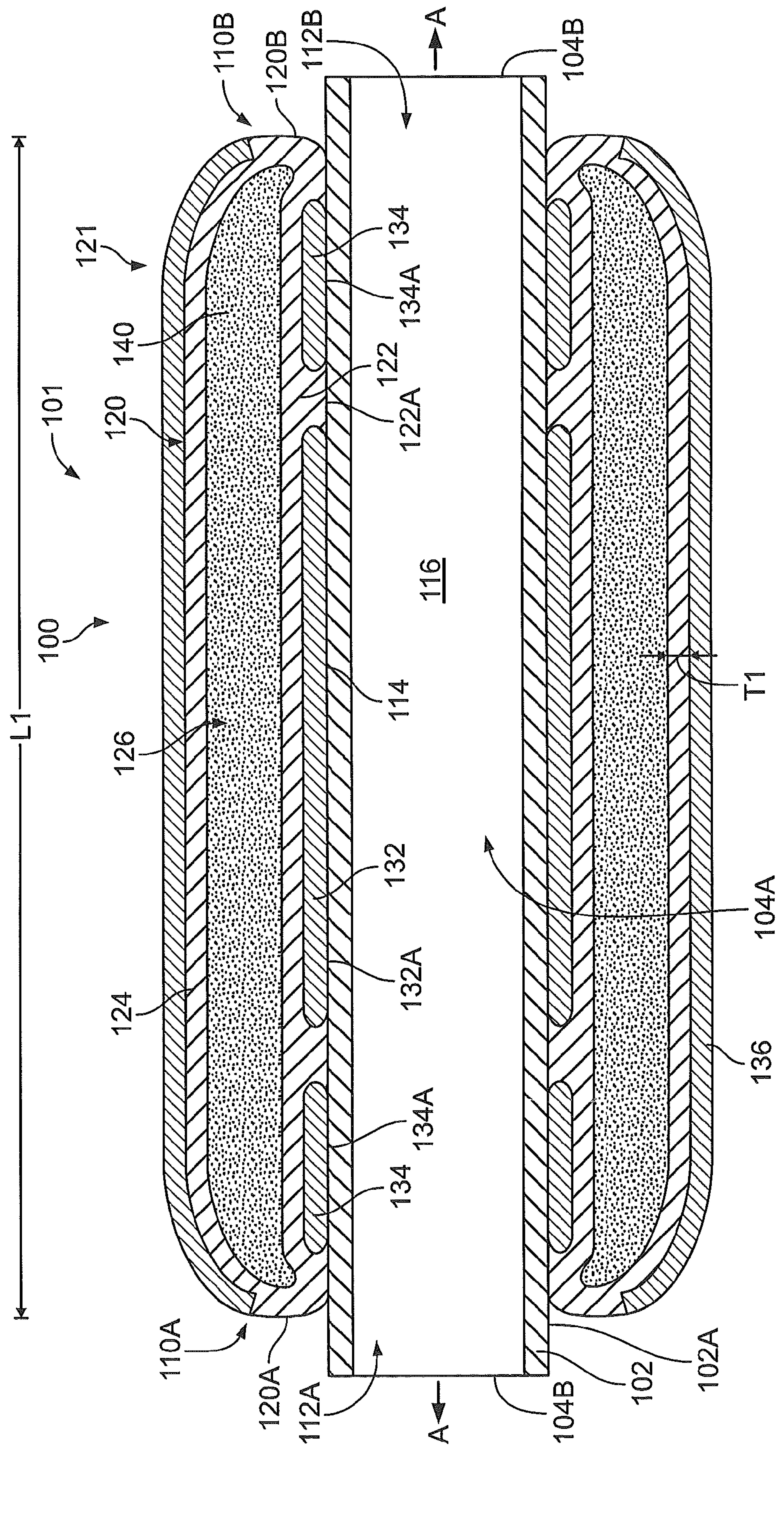

110B
120B
112B
A
104B
121
134
134A
140
122
122A
101
120
116
100
114
T1
L1
126
132
104A
132A
124
136
134A
134
110A
120A
112A
A
104B
102
102A

FIG. 3

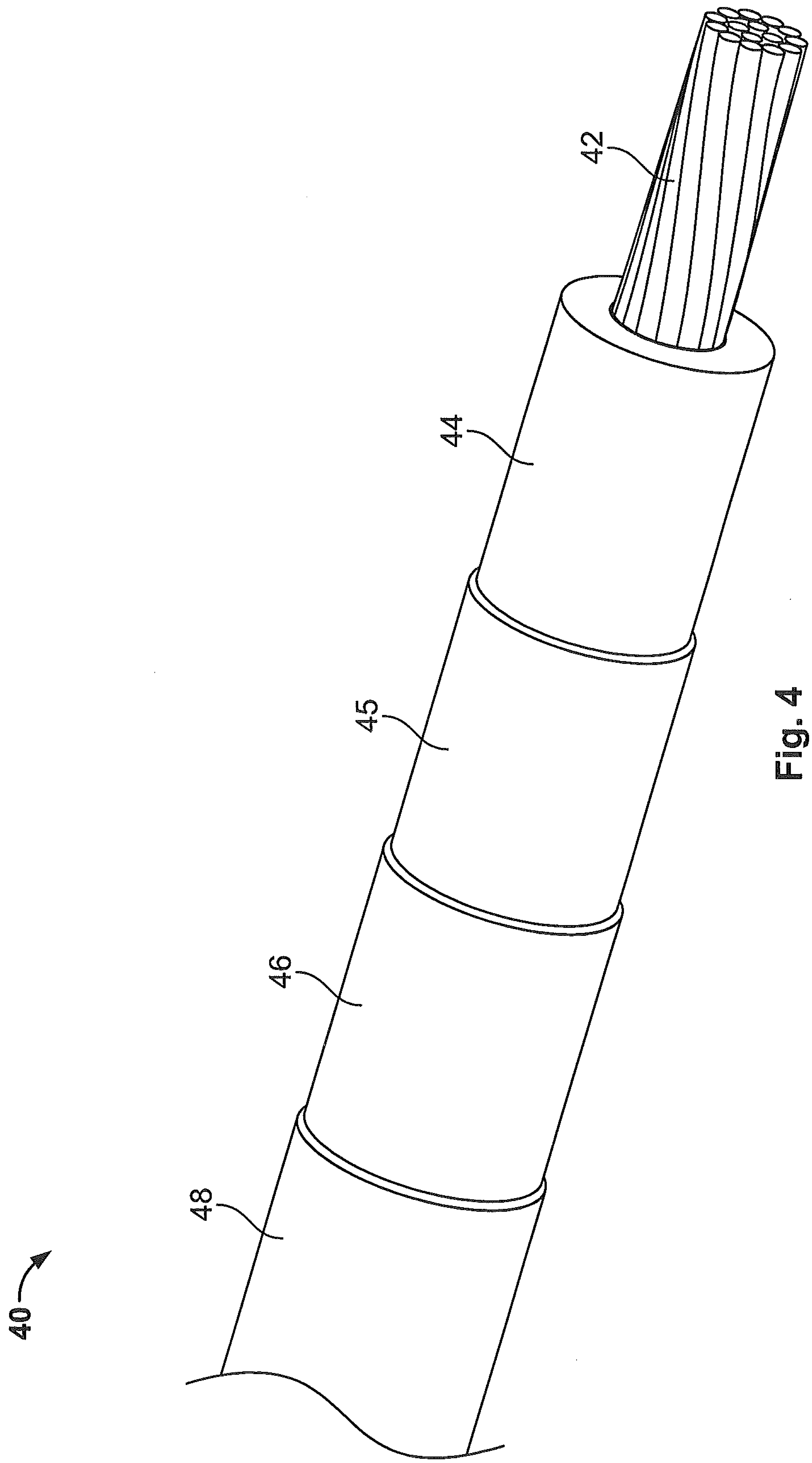


Fig. 4

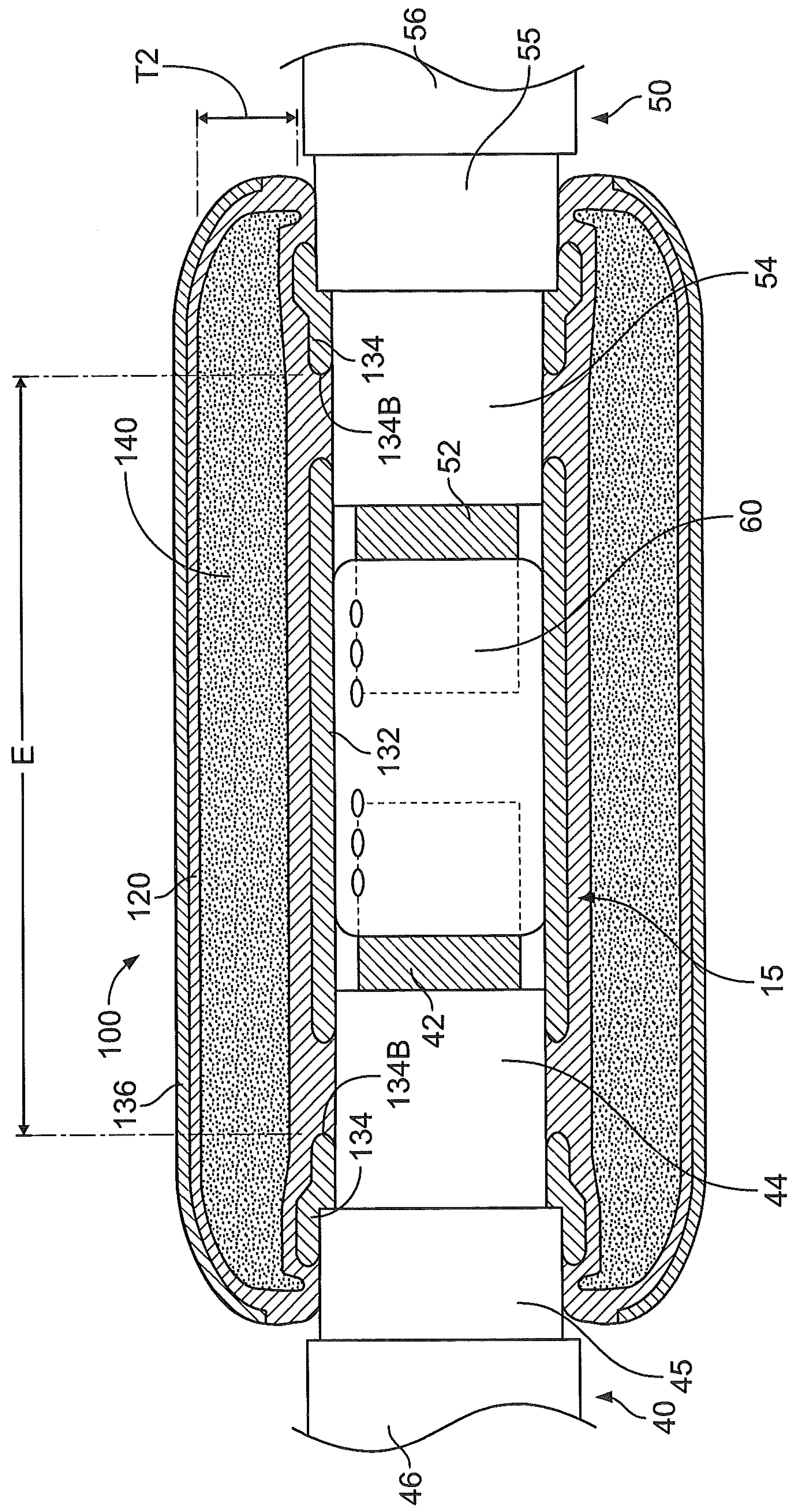
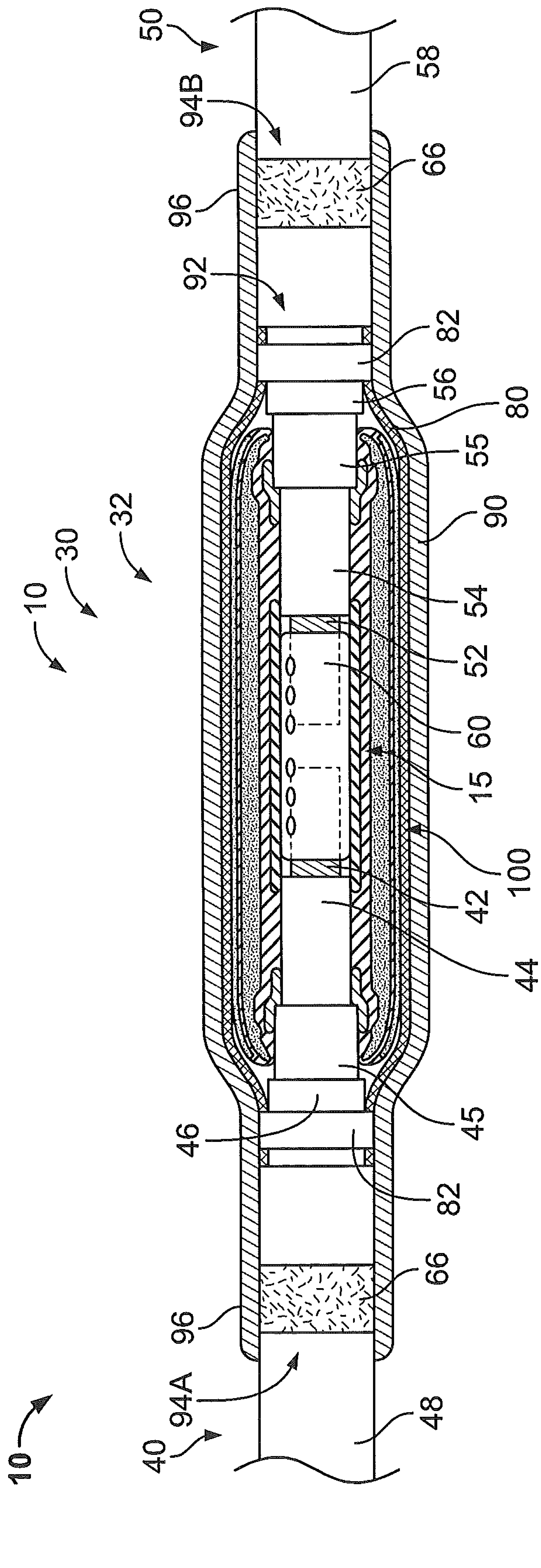

T2
56
55
50
54
134
134B
140
52
60
E
132
120
100
15
136
42
134B
134
44
45
40
46

FIG. 5


50
58
94B
66
96
92
82
56
80
55
10
30
32
90
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52
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15
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82
66
96
94A
48
40
10

Fig. 6

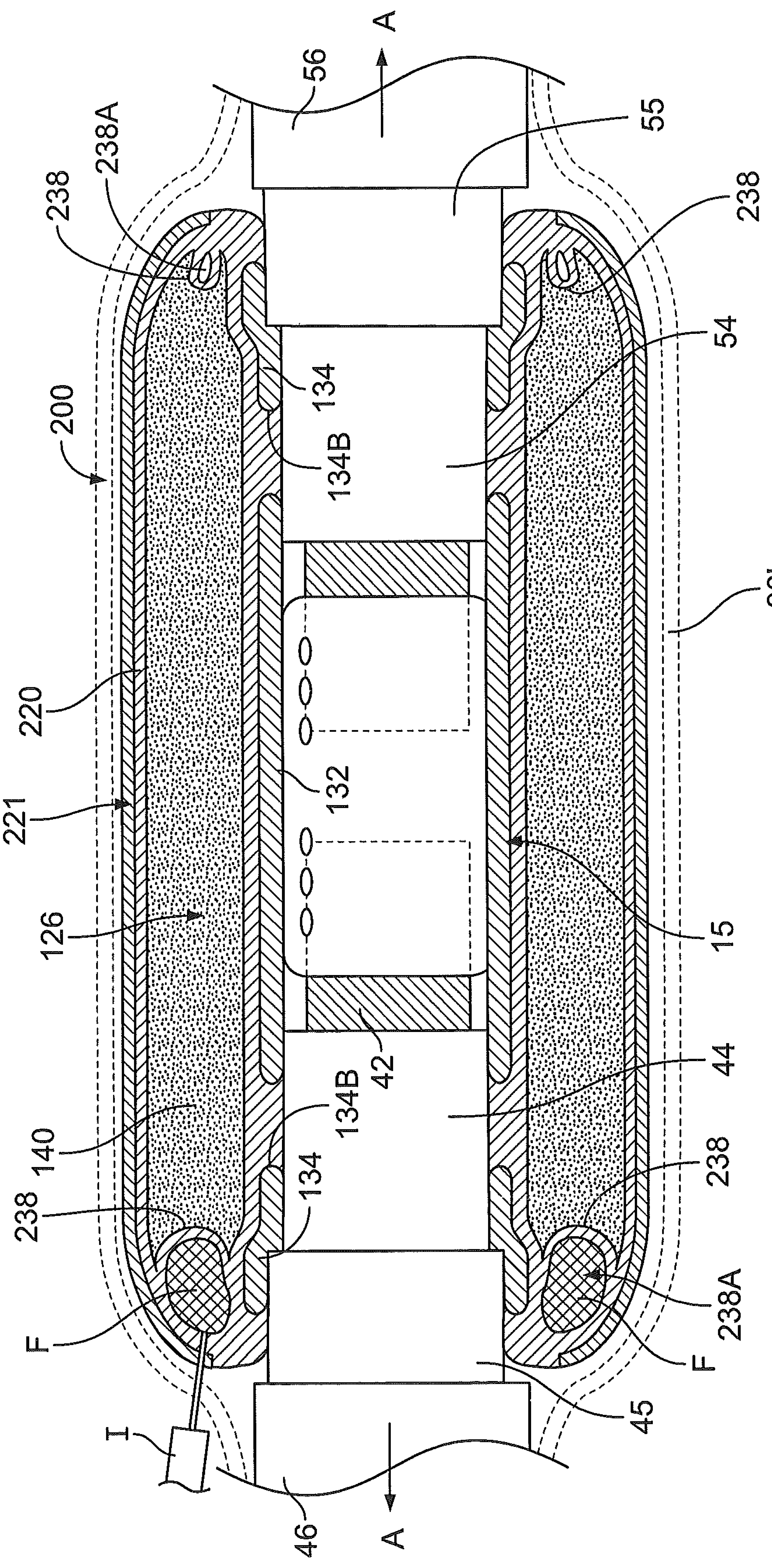
A
56
55
238A
238
238
54
134
134B
200
90'
220
132
221
15
126
42
44
134B
140
134
238
238
238A
F
F
45
I
46
A

FIG. 7

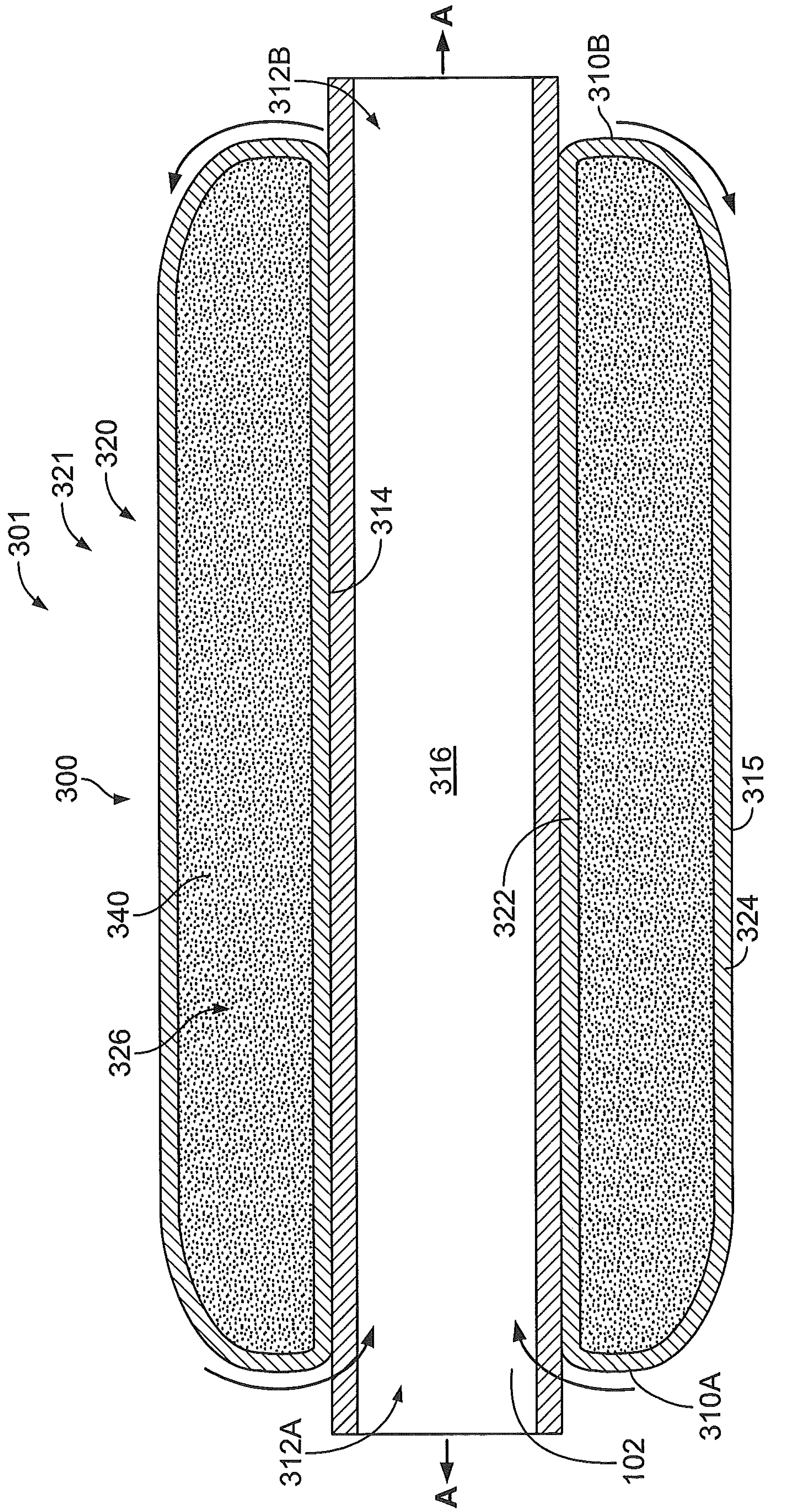
A
312B
310B
320
321
301
314
316
300
315
322
340
324
326
312A
102
310A
A

FIG. 8

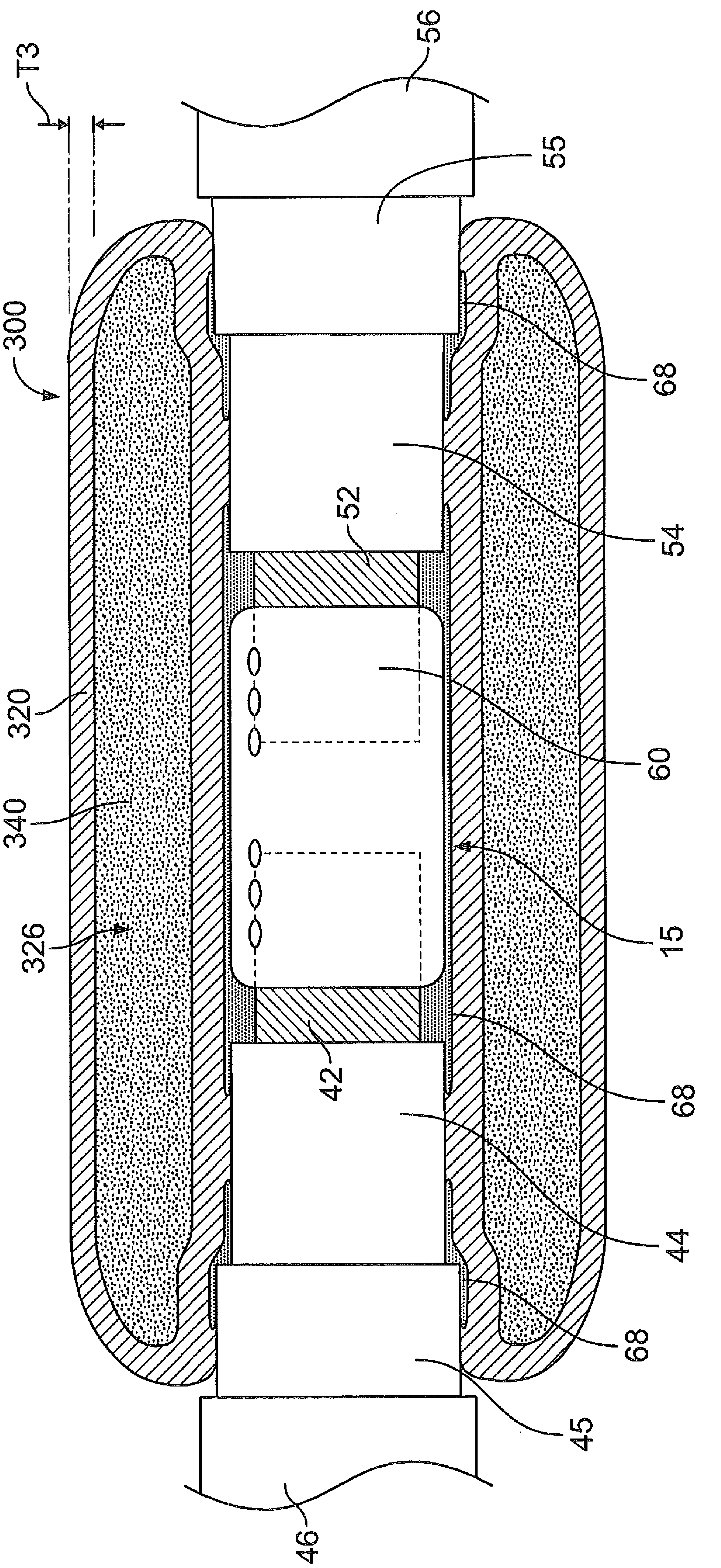

FIG. 9

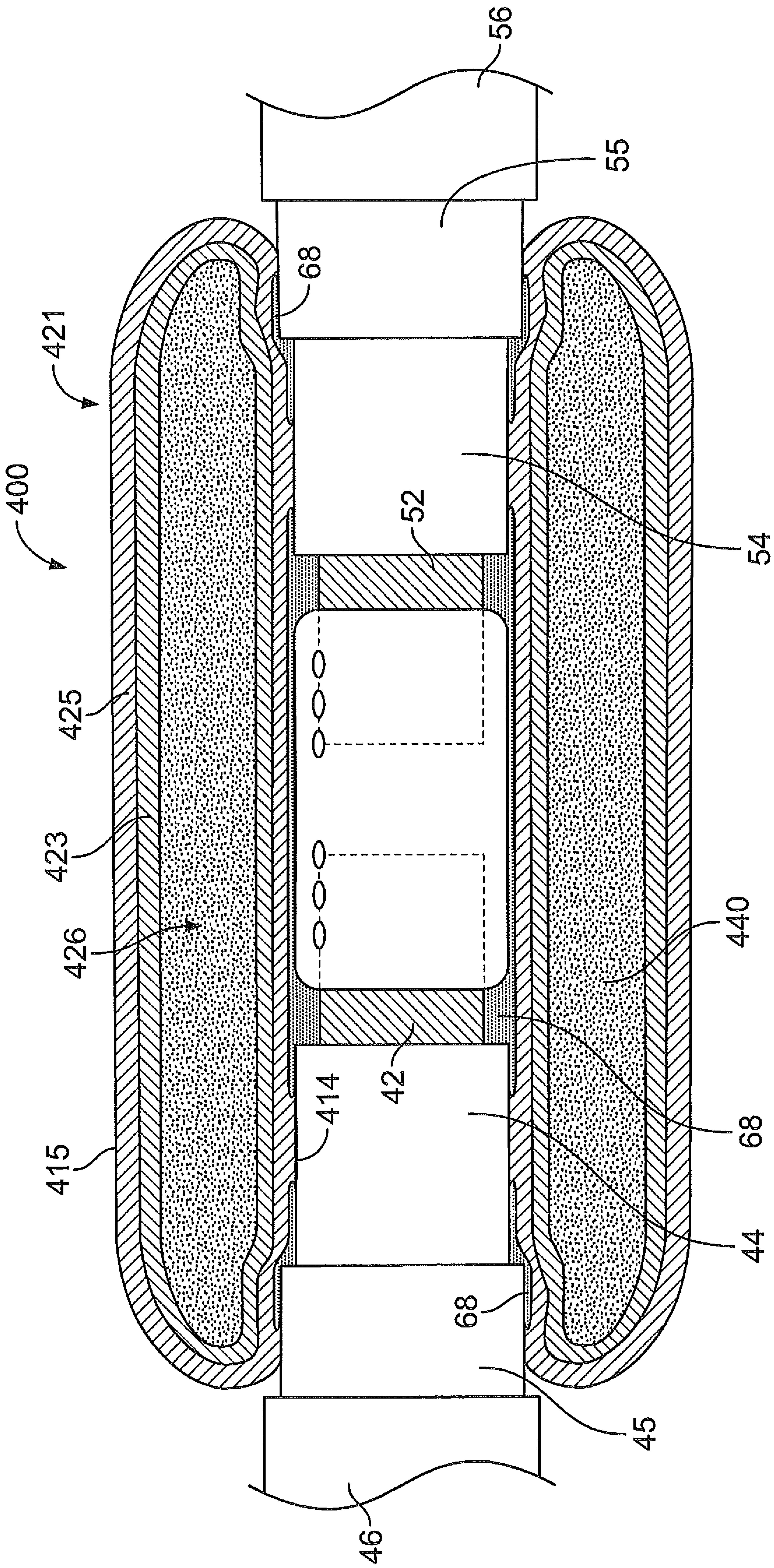

FIG. 10

JOINT BODIES AND METHODS FOR COVERING ELECTRICAL CABLES AND CONNECTIONS

FIELD OF THE INVENTION

The present invention relates to electrical cables and connections and, more particularly, to protective covers for electrical cables and electrical connections.

BACKGROUND OF THE INVENTION

In the electrical utilities industry, maintaining cable integrity may be critical. A loss of cable integrity, for example, a short circuit in a high voltage cable, may result in a crippling power outage or, even worse, a loss of life. One everyday task that may pose a great threat to cable integrity is the formation of electrical connections.

When electrical connections are formed, a bare metal surface may be exposed such as a splice connector. These bare metal surfaces may be particularly hazardous when formed in the field where they are exposed to the environment. This environment may include rocks and other sharp objects as well as moisture when the connection is to be buried under ground and rainfall when the connection is to be suspended in the air. Thus, there is a need to protect such electrical connections from the environment.

SUMMARY OF THE INVENTION

According to embodiments of the present invention, a joint body for protecting an electrical cable connection including an electrical cable includes an expandable, elastomeric bladder sleeve and an electrically insulating gel. The bladder sleeve defines a gel cavity and a cable passage to receive the electrical cable. The gel is disposed in the gel cavity and surrounds at least a portion of the cable passage. The joint body is configured to be installed on the connection such that the connection is disposed in the cable passage and is surrounded and electrically insulated by the gel.

According to method embodiments of the invention, a method of protecting an electrical cable connection including an electrical cable includes providing a joint body including: an expandable, elastomeric bladder sleeve defining a gel cavity and a cable passage to receive the electrical cable; and an electrically insulating gel disposed in the gel cavity and surrounding at least a portion of the cable passage. The method further includes installing the joint body on the connection such that the connection is disposed in the cable passage and is surrounded and electrically insulated by the gel.

According to embodiments of the invention, a protected connection assembly includes an electrical cable connection and a joint body. The connection includes an electrical cable. The joint body includes an expandable, elastomeric bladder sleeve and an electrically insulating gel. The bladder sleeve defines a gel cavity and a cable passage to receive the electrical cable. The gel is disposed in the gel cavity and surrounds at least a portion of the cable passage. The joint body as installed on the connection such that the connection is disposed in the cable passage and is surrounded and electrically insulated by the gel.

Further features, advantages and details of the present invention will be appreciated by those of ordinary skill in the art from a reading of the figures and the detailed description of the preferred embodiments that follow, such description being merely illustrative of the present invention.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a perspective view of a pre-expanded joint body unit including a joint body according to embodiments of the present invention.

FIG. **2** is a cross-sectional view of the pre-expanded joint body unit of FIG. **1** taken along the line **2-2** of FIG. **1**.

FIG. **3** is a cross-sectional view of the pre-expanded joint body unit of FIG. **1** taken along the line **3-3** of FIG. **2**.

FIG. **4** is a perspective view of an electrical cable for use with the joint body of FIG. **1**.

FIG. **5** is a cross-sectional view of the joint body of FIG. **1** installed on an electrical connection.

FIG. **6** is a cross-sectional view of a protected connection assembly including the joint body of FIG. **1**.

FIG. **7** is a cross-sectional view of a joint body according to further embodiments of the present invention mounted on an electrical connection.

FIG. **8** is a cross-sectional view of a pre-expanded joint body unit including a joint body according to further embodiments of the present invention.

FIG. **9** is a cross-sectional view of the joint body of FIG. **8** mounted on an electrical connection.

FIG. **10** is a cross-sectional view of a joint body according to further embodiments of the present invention mounted on an electrical connection.

DETAILED DESCRIPTION OF EMBODIMENTS OF THE INVENTION

The present invention now will be described more fully hereinafter with reference to the accompanying drawings, in which illustrative embodiments of the invention are shown. In the drawings, the relative sizes of regions or features may be exaggerated for clarity. This invention may, however, be embodied in many different forms and should not be construed as limited to the embodiments set forth herein; rather, these embodiments are provided so that this disclosure will be thorough and complete, and will fully convey the scope of the invention to those skilled in the art.

It will be understood that, although the terms first, second, etc. may be used herein to describe various elements, components, regions, layers and/or sections, these elements, components, regions, layers and/or sections should not be limited by these terms. These terms are only used to distinguish one element, component, region, layer or section from another region, layer or section. Thus, a first element, component, region, layer or section discussed below could be termed a second element, component, region, layer or section without departing from the teachings of the present invention.

Spatially relative terms, such as "beneath", "below", "lower", "above", "upper" and the like, may be used herein for ease of description to describe one element or feature's relationship to another element(s) or feature(s) as illustrated in the figures. It will be understood that the spatially relative terms are intended to encompass different orientations of the device in use or operation in addition to the orientation depicted in the figures. For example, if the device in the figures is turned over, elements described as "below" or "beneath" other elements or features would then be oriented "above" the other elements or features. Thus, the exemplary term "below" can encompass both an orientation of above and below. The device may be otherwise oriented (rotated 90° or at other orientations) and the spatially relative descriptors used herein interpreted accordingly.

As used herein, the singular forms "a", "an" and "the" are intended to include the plural forms as well, unless expressly stated otherwise. It will be further understood that the terms "includes," "comprises," "including" and/or "comprising," when used in this specification, specify the presence of stated features, integers, steps, operations, elements, and/or components, but do not preclude the presence or addition of one or more other features, integers, steps, operations, elements, components, and/or groups thereof. It will be understood that when an element is referred to as being "connected" or "coupled" to another element, it can be directly connected or coupled to the other element or intervening elements may be present. As used herein, the term "and/or" includes any and all combinations of one or more of the associated listed items.

Unless otherwise defined, all terms (including technical and scientific terms) used herein have the same meaning as commonly understood by one of ordinary skill in the art to which this invention belongs. It will be further understood that terms, such as those defined in commonly used dictionaries, should be interpreted as having a meaning that is consistent with their meaning in the context of this specification and the relevant art and will not be interpreted in an idealized or overly formal sense unless expressly so defined herein.

As used herein, "cold-applied" or "cold-applied cover" means that the cover or component can be assembled or installed about a substrate (e.g., a cable) without requiring the use of applied heat at the time of installation.

As used herein, "cold shrink" or "cold shrink cover" means that the cover or component can be shrunk or contracted about a substrate (e.g., a cable) without requiring the use of applied heat.

With reference to FIGS. **1-6**, a joint body **100** according to some embodiments of the present invention is shown therein. The joint body **100** may be provided as a pre-expanded joint body unit **101** including a holdout device **102**, as shown in FIGS. **1-3**, wherein the joint body **100** is in an expanded state or position.

The joint body **100** may be used to cover and electrically insulate electrical substrates such as cables and connectors. The joint body **100** may be used to cover and seal a connection or splice **15** between two or more cables **40**, **50** including an electrical connector **60** to form a protected connection assembly **10** as shown in FIG. **6** (in this case, the joint body **100** may be referred to as a splice body). According to some embodiments, the cables **40**, **50** are concentric neutral cables. According to some embodiments, the cables **40**, **50** are metal tape shielded or longitudinally corrugated (LC) metal shielded cables. The joint body **100** may form a part of a cover system **30** further including one or more of a grounding and/or electrical shielding member (e.g., a copper mesh) **80**, securing clamps **82**, an outer or rejacketing sleeve **90**, and cable sealing mastic **66**, as shown in FIG. **6**. When installed on the connection and cables, the cover system **30** forms a cover assembly **32** about the connection **15**, thereby forming the protected connection assembly **10**.

The joint body **100** may be deployed and mounted on the intended substrate in a retracted state or position as shown in FIGS. **5** and **6** and discussed in more detail below. According to some embodiments, the joint body **100** is a cold shrink cover, meaning that it can be shrunk or retracted about the substrate without requiring the use of applied heat.

The joint body **100** includes a containment or bladder sleeve **121** defining a chamber or cavity **126** filled with a mass of an electrically insulating gel **140**, as discussed in more detail below.

The joint body **100** has a longitudinal central joint body axis A-A and extends from an end **110**A to an opposing end **110**B along the axis A-A. Openings **112**A and **112**B are defined at the ends **110**A and **110**B and communicate with an axially extending through passage **116** defined by an inner surface **114** of the joint body **100**.

The bladder sleeve **121** is a tubular, integral, double-walled sleeve of unitary or single-piece construction. The sleeve **121** extends axially from an end **120**A to an opposing end **120**B. The sleeve **121** has a tubular inner wall **122** and a tubular outer wall **124** joined at the ends **120**A, **120**B. The inner wall **122** forms, in part, the inner surface **114**. The walls of the sleeve **121** form an endless, continuous band. The cavity **126** is defined as an annular or tubular cavity between the inner wall **122** and the outer wall **124**.

The bladder sleeve **121** includes a primary bladder layer **120**, an integral Faraday cage layer **132**, a pair of integral stress cone layers **134**, and an integral outer screen or semiconductive layer **136**. According to some embodiments and as illustrated, the primary bladder layer **120** is a tubular, integral, double-walled sleeve of unitary or single-piece construction. The Faraday cage layer **132** and the stress cone layers **134** are mounted on the inner wall **122** and form parts of the inner surface **114**. The outer semiconductor layer **136** is mounted on the outer wall **124**. According to some embodiments and as shown, the layers **132**, **134**, **136** are embedded in the walls **122**, **124**. In some embodiments, the inner surfaces **132**A, **134**A of the layers **132**, **134** are substantially axially coplanar with the inner surface **122**A of the inner wall **122** so that the joint body inner surface **114** of the joint body **100** presents a substantially uniform profile.

The primary bladder layer **120** can be formed of any suitable material. According to some embodiments, the bladder layer **120** is formed of a dielectric or electrically insulative material. According to some embodiments, the bladder layer **120** is formed of an elastically expandable material. According to some embodiments, the bladder layer **120** is formed of an elastomeric material. According to some embodiments, the bladder layer **120** is formed of liquid silicone rubber (LSR). Other suitable materials may include EPDM or ethylene propylene rubber (EPR). According to some embodiments, the bladder layer **120** has a Modulus at 100 percent elongation (M**100**) in the range of from about 0.10 to 1 MPa. According to some embodiments, the bladder layer **120** has a Shore A hardness of less than 40 and, in some embodiments, in the range of from about 30 to 50.

According to some embodiments, the thickness T**1** (FIG. **3**) of the bladder layer **120** is in the range from about 0.5 to 5 mm. According to some embodiments, the length L**1** (FIG. **3**) of the bladder layer **120** is in the range of from about 150 to 700 mm.

The Faraday cage layer **132** is a generally tubular sleeve bonded to the inner surface of the wall **122**. The Faraday cage layer **132** may be formed of a suitable elastically conductive elastomer. In use, the Faraday cage layer **132** may form a Faraday cage to provide an equal potential volume about the connector **60** so that an electric field is cancelled in the surrounding air voids. The Faraday cage layer **132** has a Faraday cage interface surface **132**A defining a portion of the joint body inner surface **114**, and thereby a portion of the passage **116**.

The stress cone layers **134** are axially spaced apart, generally tubular sleeves bonded to the inner surface of the wall **122** proximate either end **110**A, **110**B of the joint body **100**. The stress cone layers **134** may be formed of a suitable electrically conductive elastomer. In use, the stress cone layers **134** may serve to redistribute the voltage along the surface of the cable insulation **44**, **54** to reduce or prevent the degradation of the insulation **44**, **54** that might otherwise occur. Each stress cone layer **134** has a stress cone interface surface **134**A defining a portion of the joint body inner surface **114**, and thereby a portion of the passage **116**.

According to some embodiments, the Faraday cage layer **132** and the stress cone layers **134** are formed of a material having a Modulus at 100 percent elongation (M**100**) in the range of from about 0.5 to 2 MPa. According to some embodiments, the Faraday cage layer **132** and the stress cone layers **133** have a Shore A hardness of less than 80 and, in some embodiments, in the range of from about 50 to 70.

The semiconductive layer **136** is a generally tubular sleeve bonded to the outer surface of the wall **124** and fully circumferentially surrounds the layer **120**. According to some embodiments, the semiconductive layer **136** extends axially at least the full distance between and overlaps the stress cone layers **134**.

The semiconductive layer **136** can be formed of any suitable electrically semiconductive material. According to some embodiments, the semiconductive layer **136** is formed of an elastically expandable material. According to some embodiments, the semiconductive layer **136** is formed of an elastomeric material. According to some embodiments, the semiconductive layer **136** is formed of carbon black and silicone. Other suitable materials may include carbon black and EPDM. According to some embodiments, the semiconductive layer **136** is formed of a material having a Modulus at 100 percent elongation (M**100**) in the range of from about 0.5 to 2 MPa.

The gel sealant **140** may be any suitable gel sealant. As used herein, "gel" refers to the category of materials which are solids extended by a fluid extender. The gel may be a substantially dilute system that exhibits no steady state flow. As discussed in Ferry, "Viscoelastic Properties of Polymers," 3rd ed. P. 529 (J. Wiley & Sons, New York 1980), a polymer gel may be a cross-linked solution whether linked by chemical bonds or crystallites or some other kind of junction. The absence of the steady state flow may be considered to be the definition of the solid-like properties while the substantial dilution may be necessary to give the relatively low modulus of gels. The solid nature may be achieved by a continuous network structure formed in the material generally through crosslinking the polymer chains through some kind of junction or the creation of domains of associated substituents of various branch chains of the polymer. The crosslinking can be either physical or chemical as long as the crosslink sites may be sustained at the use conditions of the gel.

Gels for use in this invention may be silicone (organopolysiloxane) gels, such as the fluid-extended systems taught in U.S. Pat. No. 4,634,207 to Debbaut (hereinafter "Debbaut '207"); U.S. Pat. No. 4,680,233 to Camin et al.; U.S. Pat. No. 4,777,063 to Dubrow et al.; and U.S. Pat. No. 5,079,300 to Dubrow et al. (hereinafter "Dubrow '300"), the disclosures of each of which are hereby incorporated herein by reference. These fluid-extended silicone gels may be created with nonreactive fluid extenders as in the previously recited patents or with an excess of a reactive liquid, e.g., a vinyl-rich silicone fluid, such that it acts like an extender, as exemplified by the Sylgard® 527 product commercially available from Dow-Corning of Midland, Mich. or as disclosed in U.S. Pat. No. 3,020,260 to Nelson. Because curing is generally involved in the preparation of these gels, they are sometimes referred to as thermosetting gels. The gel may be a silicone gel produced from a mixture of divinyl terminated polydimethylsiloxane, tetrakis (dimethylsiloxy)silane, a platinum divinyltetramethyldisiloxane complex, commercially available from United Chemical Technologies, Inc. of Bristol, Pa., polydimethylsiloxane, and 1,3,5,7-tetravinyltetra-methylcyclotetrasiloxane (reaction inhibitor for providing adequate pot life).

Other types of gels may be used, for example, polyurethane gels as taught in the aforementioned Debbaut '261 and U.S. Pat. No. 5,140,476 to Debbaut (hereinafter "Debbaut '476") and gels based on styrene-ethylene butylenestyrene (SEBS) or styrene-ethylene propylene-styrene (SEPS) extended with an extender oil of naphthenic or nonaromatic or low aramatic content hydrocarbon oil, as described in U.S. Pat. No. 4,369,284 to Chen; U.S. Pat. No. 4,716,183 to Gamarra et al.; and U.S. Pat. No. 4,942,270 to Gamarra. The SEBS and SEPS gels comprise glassy styrenic microphases interconnected by a fluid-extended elastomeric phase. The microphase-separated styrenic domains serve as the junction points in the systems. The SEBS and SEPS gels are examples of thermoplastic systems.

Another class of gels which may be used are EPDM rubber-based gels, as described in U.S. Pat. No. 5,177,143 to Chang et al.

Yet another class of gels which may be used are based on anhydride-containing polymers, as disclosed in WO 96/23007. These gels reportedly have good thermal resistance.

The gel may include a variety of additives, including stabilizers and antioxidants such as hindered phenols (e.g., Irganox™ 1076, commercially available from Ciba-Geigy Corp. of Tarrytown, N.Y.), phosphites (e.g., Irgafos™ 168, commercially available from Ciba-Geigy Corp. of Tarrytown, N.Y.), metal deactivators (e.g., Irganox™ D1024 from Ciba-Geigy Corp. of Tarrytown, N.Y.), and sulfides (e.g., Cyanox LTDP, commercially available from American Cyanamid Co. of Wayne, N.J.), light stabilizers (e.g., Cyasorb UV-531, commercially available from American Cyanamid Co. of Wayne, N.J.), and flame retardants such as halogenated paraffins (e.g., Bromoklor 50, commercially available from Ferro Corp. of Hammond, Ind.) and/or phosphorous containing organic compounds (e.g., Fyrol PCF and Phosflex 390, both commercially available from Akzo Nobel Chemicals Inc. of Dobbs Ferry, N.Y.) and acid scavengers (e.g., DHT-4A, commercially available from Kyowa Chemical Industry Co. Ltd through Mitsui & Co. of Cleveland, Ohio, and hydrotalcite). Other suitable additives include colorants, biocides, tackifiers and the like described in "Additives for Plastics, Edition 1" published by D.A.T.A., Inc. and The International Plastics Selector, Inc., San Diego, Calif.

The hardness, stress relaxation, and tack may be measured using a Texture Technologies Texture Analyzer or like machine, having a load cell to measure force, a 5 gram trigger, and ¼ inch (6.35 mm) stainless steel probe. For measuring the hardness, for example, of a 20 mL glass vial containing 12 grams of gel, the probe is forced into the gel at the speed of 0.2 mm/sec to a penetration distance of 4.0 mm. The hardness of the gel is the force in grams required to force the probe at that speed to penetrate the gel specified for 4.0 mm, Higher numbers signify harder gels.

The tack and stress relaxation are read from the stress curve generated by tracing the force versus time curve experienced by the load cell when the penetration speed is 2.0 mm/second and the probe is forced into the gel a penetration distance of about 4.0 mm. The probe is held at 4.0 mm penetration for 1 minute and withdrawn at a speed of 2.00 mm/second. The stress relaxation is the ratio of the initial force (F_i) resisting the probe at the pre-set penetration depth minus the force resisting the probe (F_f) after 1 min divided by the initial force F_i, expressed as a percentage. That is, percent stress relaxation is equal to

$$1.\ \frac{(F_i - F_f)}{F_i} \times 100\%$$

where F_i and F_f are in grams. In other words, the stress relaxation is the ratio of the initial force minus the force after 1 minute over the initial force. It may be considered to be a measure of the ability of the gel to relax any induced compression placed on the gel. The tack may be considered to be the amount of force in grams resistance on the probe as it is pulled out of the gel when the probe is withdrawn at a speed of 2.0 mm/second from the preset penetration depth.

An alternative way to characterize the gels is by cone penetration parameters according to ASTM D-217 as proposed in Debbaut '261; Debbaut '207; Debbaut '746; and U.S. Pat. No. 5,357,057 to Debbaut et al., each of which is incorporated herein by reference in its entirety. Cone penetration ("CP") values may range from about 70 (10^{1} mm) to about 400 (10^{-1} mm). Harder gels may generally have CP values from about 70 (10^{-1} mm) to about 70 (10^{-1} mm). Softer gels may generally have CP values from about 200 (10^{-1} mm) to about 400 (10^{-1} mm), with particularly preferred range of from about 250 (10^{-1} mm) to about 375 (10^{-1} mm). For a particular materials system, a relationship between CP and Voland gram hardness can be developed as proposed in U.S. Pat. No. 4,852,646 to Dittmer et al.

According to some embodiments, the gel **140** has a Voland hardness, as measured by a texture analyzer, of between about 5 and 100 grams force.

According to some embodiments, the gel **140** has an elongation, as measured in accordance with ASTM D638-10 (dated May 15, 2010), of at least 55%. According to some embodiments, the elongation is of at least 100%. The gel **140** may have a stress relaxation of less than 80%. The gel **140** may have a tack greater than about 1 gram.

According to some embodiments, the gel **140** has a volume resistivity of at least 10^{12} Ohm-cm and, in some embodiments, in the range of from about 10^{12} to 10^{15} Ohm-cm.

According to some embodiments, the gel **140** has a dielectric strength of at least 20 kV/cm and, in some embodiments, in the range of from about 15 to 25 kV/cm.

According to some embodiments, the gel **140** has a dielectric constant of at least 2 and, in some embodiments, in the range of from about 2.3 to 5.0.

According to some embodiments, the cover assembly **100** is provided pre-installed (e.g., at the factory) and pre-expanded on the holdout **102**. The holdout **102** can be formed of any suitable material. The holdout **102** has an outer surface **102**A and defines a through passage **104**A communicating with opposed end openings **104**B (FIG. **3**). According to some embodiments, the holdout **102** includes axially extending sets of ribs **102**B (FIG. **1**). Grease or other lubricant may be provided in the channels **102**C defined between the ribs **102**B. The illustrated holdout **102** is a rigid, non-collapsible tube holdout. However, other types of holdouts may be employed. For example, the holdout may include a flexible strip helically wound to form a rigid cylinder and having a pull tab or end segment extending through the passage. According to some embodiments, the holdout **102** is formed of a rigid or semi-rigid polymeric material. According to some embodiments, the holdout **102** is formed of rigid cardboard, polypropylene, ABS, or PVC. The holdout device **102** may be factory installed in the joint body **100**.

The joint body **100** and the pre-expanded unit **101** may be formed by any suitable method and apparatus. According to some embodiments, the gel **140** is pre-installed and sealed in the cavity **126** of the bladder layer **120**, and the joint body **100** is thereafter installed on the holdout **102**. According to some embodiments, the bladder layer **120** is formed, uncured gel material is inserted into the cavity **126**, the uncured gel material is cured in situ within the cavity into the gel **140**, and the gel **140** is fully sealed within the cavity **126** (before or after curing). In some embodiments, each of these steps is conducted at the factory. In this case, the bladder layer **120** is pre-filled with the cured gel **140** and the gel **140** is fully contained and sealed in the cavity **126** so that it is not necessary for an installer to handle or prepare the gel **140**.

According to some embodiments, when mounted on the holdout **102**, the joint body **100** is maintained in an elastically radially expanded state or position. According to some embodiment, in the expanded state the joint body **100** is expanded in the range of from about 5 to 100 percent of its relaxed diameter.

The outer sleeve **90** (FIG. **6**) is tubular and defines an axially extending through passage **92** that communicates with opposed end openings at the ends **94**A, **94**B.

The outer sleeve **90** can be formed of any suitable material. According to some embodiments, the outer sleeve **90** is formed of an electrically insulative material. According to some embodiments, the outer sleeve **90** is formed of a polymeric material.

According to some embodiments, the outer sleeve **90** is a cold-shrinkable tube formed of an elastomeric material. The cold-shrinkable tube may be mounted on a holdout. According to some embodiments, the outer sleeve **90** is formed of EPDM rubber. Other suitable materials may include silicone rubber. According to some embodiments, the outer sleeve **90** has a Modulus at 100 percent elongation (M**100**) in the range of from about 0.25 to 2 MPa. According to some embodiments, the thickness of the outer sleeve **90** is in the range of from about 0.10 to 0.25 inch.

According to some embodiments, the outer sleeve **90** is a heat shrinkable tube formed of thermoplastic material. According to some embodiments, the outer sleeve **90** is formed of a thermoplastic polyolefin.

Referring now to FIG. **5**, the joint body **100** and the cover system **30** may be applied over a splice connection **15** between a pair of electrical power transmission cables **40**, **50** to form a protected connection assembly **10**. According to some embodiments, the cables **40**, **50** are medium-voltage (e.g., between about 5 and 35 kV) or high-voltage (e.g., between about 46 and 230 kV) power transmission cables.

As shown in FIG. **4**, the cable **40** includes a primary electrical conductor **42**, a polymeric insulation layer **44**, a semiconductor layer **45**, a metal electromagnetic radiation shield layer **46**, and a jacket **48**, with each component being concentrically surrounded by the next.

According to some embodiments and as shown, the shield layer **46** is a metal tape, foil, strip or sheath fully circumferentially surrounding the semiconductor layer **45** along the length of the cable. The metal strip may be longitudinally or helically wrapped about the semiconductor layer **45**, for example. According to some embodiments, the cable **40** is an LC shielded cable and the shield layer **46** is a thin corrugated metal layer. In other embodiments, the shield layer **46** may include individual wires, which may be helically wound about the semiconductor layer **45**.

The primary conductor **42** may be formed of any suitable electrically conductive materials such as copper (solid or stranded). The polymeric insulation layer **44** may be formed of any suitable electrically insulative material such as crosslinked polyethylene (XLPE) or EPR. The semiconductor layer **45** may be formed of any suitable semiconductor material such as carbon black with silicone. The shield layer **46** may be formed of any suitable material such as copper. The jacket **48** may be formed of any suitable material such as EPDM or PVC.

The cable **50** (FIG. **6**) is similarly constructed with a primary electrical conductor **52**, a polymeric insulation layer **54**, a semiconductor layer **55**, a metal shield layer **56**, and a jacket **58** corresponding to components **42**, **44**, **45**, **46** and **48**, respectively.

The connection assembly **32** may be formed and the joint body **100** may be installed as follows. The cables **40**, **50** are prepared as shown in FIG. **6** such that a segment of each layer extends beyond the next overlying layer.

The pre-expanded unit **101** is slid over one of the cables **40**, **50**. According to some embodiments, the inside diameter of the holdout **102** is greater than the outer diameter of each cable **40**, **50** and the connector **60** such that the inner diameter of the holdout **102** is sufficient to receive the prepared cable **40**, **50** and the connector **60** without undue effort. According to some embodiments, the inner diameter of the holdout **102** is at least as great as the outer diameter of the largest portion of the cables or connector that are to be received in the passage **116** of the joint body **100**. The pre-expanded unit **101** may be retained or parked on a cable **40**, **50** until the operator is ready to install the cover assembly **100** on the cables **40**, **50**.

The electrical connector **60** is secured to each primary conductor **42**, **52** to mechanically and electrically couple the primary conductors **42**, **52** to one another as shown in FIG. **5**. The connector **60** may be any suitable type of connector such as a metal crimp connector.

The pre-expanded unit **101** is then slid into position adjacent, but not over, the connector **60**. The joint body **100** is then pushed off the holdout **102** and over the connector **60** and adjacent portions of the cables **40**, **50**, thereby permitting the joint body **100** to relax and radially retract about the cables **40**, **50** and the connector **60** as shown in FIG. **6**, as discussed in more detail below.

Alternatively, the pre-expanded unit **101** is slid into position over the connector **60**. The holdout **102** is then withdrawn or removed from the joint body **100**, thereby permitting the joint body **100** to relax and radially retract about the cables **40**, **50** and the connector **60** as shown in FIG. **6**.

According to some embodiments, when installed, the joint body **100** is not fully recovered to its relaxed state, and therefore continues to apply a persistent radially compressive load or pressure to the cables **40**, **50** and the connector **60**.

According to some embodiments, the inner surface **114** of the bladder layer **120** directly engages the cables **40**, **50** and the connector **60**. According to some embodiments, the installed joint body **100** overlaps and engages the semiconductor layers **45**, **55** of the cables **40**, **50**. More particularly, the each stress cone layer **134** overlaps and engages the semiconductor layer **45**, **55** and the insulation layer **44**, **54** of the respective cable **40**, **50**. The Faraday cage layer **132** overlaps and engages the connector **60** and the insulation layer **44**, **54** of each cable **40**, **50**.

The shield mesh **80** may then wrapped around the joint body **100** and the semiconductor layers **45**, **55** as shown in FIG. **6**. A retainer **82** (e.g., a metal mesh web or clamp) can be wrapped about each cable **40**, **50** as also shown in FIG. **6** to secure the end edges of the shield mesh **80**. The retainers **82** may be wrapped about exposed ends of the shield layers **46**, **56** to electrically connect the shield mesh **80** to the shield layers **46**, **56**. According to some embodiments, the shield mesh layer **80** fully circumferentially surrounds the joint body **100**. According to some embodiments, the shield mesh layer **80** includes opposed end sections that extend beyond the ends of the joint body **100** but do not extend as far out as the outer sleeve **90**. The shield mesh layer **80** may be formed of braided or woven copper filaments, for example.

Strips of flowable sealant **66** (FIG. **6**) may be applied to the outer surfaces of the cable jackets **48**, **58**. According to some embodiments, the sealant **66** is a mastic. The operator then installs the outer sleeve **90** around the joint body **100** and the cables **40**, **50** such that opposed end sections **96** of the outer sleeve **90** extend axially outwardly to cover the adjacent sections of the cables **40** and **50**, respectively. According to some embodiments, at least a portion of each end section **96** overlaps a respective portion of each cable jacket **48**, **58** and engages the associated sealant strip **66** to provide a moisture seal. According to some embodiments, the axial length of overlap between each end section **96** and the underlying jacket **48**, **58** is at least 3 inches.

According to some embodiments, the installed outer sleeve **140** exerts a radially inwardly compressive or clamping force or pressure onto the cables **40**, **50**. The outer sleeve **90** may thereby effect a liquid tight seal at the interfaces between the end sections **96** and the cable jackets **48**, **58** and at the interfaces between the cable jackets **48**, **58** and the outer sleeve **90**. These seals can protect the cable and the splice from the ingress of environmental moisture.

The relaxed inner diameter of the joint body **100** is less than at least the outer diameter of the cable insulation layers **44**, **54**. Therefore, the joint body **100** exerts a radially inwardly compressive or clamping force or pressure (due to elastic tension) onto the cables **40**, **50** and the connector **60**.

According to some embodiments, the installed joint body **100** applies a radially compressive load to the cables **40**, **50** in the range of from about 10 to 60 psi.

According to some embodiments, the gel **140** has a nominal thickness T2 (FIG. **5**) in the range of from about 0.10 to 1 inch in the span E defined between the inner edges **134**B of the stress cone layers **134**.

In some embodiments, it may be necessary or desirable to provide a supplemental restraint or compressive loading device about the joint body **100** to retain or increase the interface pressure between the inner wall **122** and the cables **40**, **50** to ensure that the joint body **100** is sufficiently loaded against the cables **40**, **50**. The outer sleeve **90** may serve as a restraint or loading device to externally pressurize the joint body **100**.

In some embodiments, the outer sleeve **90** is a heat shrink tube that is placed about the installed joint body **100** and then heat shrunk (i.e., by application of heat thereto) to contract the outer sleeve **90** about the joint body **100**. The contracted heat shrink tube **90** may remain elastic and apply a persistent radially compressive load to the joint body **100** or may form a rigid shell.

In some embodiments, the outer sleeve **90** is a cold shrinkable elastomeric sleeve. The cold shrink sleeve **90** is placed about the installed joint body **100** in a radially expanded state and then released to radially contract about the joint body **100**. The contracted cold shrink tube **90** may apply a persistent radially compressive load to the joint body **100**.

In some embodiments, the outer sleeve **90** is a cold-applied wrap-around sleeve (elastomeric or thermoplastic). The wrap-around sleeve **90** is wrapped circumferentially tightly about the installed joint body **100** to radially compress the joint body **100**. The wrap-around sleeve **90** may apply a persistent radially compressive load to the joint body **100**.

In further embodiments, the outer sleeve **90** is a tape (e.g., a self-amalgamating tape) that is wrapped (e.g., helically) around installed joint body **100**. The tape may remain elastic or may form a rigid shell.

In still further embodiments, the outer sleeve **90** is formed of two or more preformed rigid shells that are installed about the installed joint body **100** to partly or fully envelope the joint body **100**. The shells may be configured and mounted such that they radially compress the joint body **100**.

While a single, unitary outer sleeve **90** is illustrated, a plurality of outer sleeves may be used to cover the joint body **100**. For example, two or more heat shrink tubes (or cold shrink tubes) may be mounted in axially seriated and imbricated relation about the joint body **100**.

The foregoing outer sleeves **90** may be relied on alone to constrain and/or apply compression to the joint body **100**. Alternatively, additional filler or pressurizing material may be injected into the cavity defined by the outer sleeve **90** or into the joint body **100** itself. For example, a pressurizing material may be injected between the outer sleeve **90** and the joint body **100** after the outer sleeve **90** has been installed about the joint body **100**. The pressurizing material may be foam, compressed air, silicone compound, oil (e.g., mineral oil), or other suitable material. In some embodiments, the pressurizing material is a self-expanding foam (e.g., a PUR foam) that, once injected, volumetrically expands in situ to pressurize the joint body **100**. In some embodiments, the pressurizing material is injected under pressure to apply the desired pressurization of the joint body **100**.

In some embodiments, compression devices (in some embodiments, heat shrink tubes) are applied about the ends of the joint body **100** where the electrical field is screened by the stress cone layers **134** (i.e., axially outboard of the inner edges of the stress cone layers **134**). These compression devices radially compress the ends of the joint body **100**, displacing gel **140** from the ends of the bladder layer **120** and thereby pressurizing the bladder layer **120** internally and increasing the interface pressure between the inner wall **122** and the cables **40**, **50**.

With reference to FIG. **7**, a joint body **200** is shown therein corresponding to the joint body **100** (and identical numerals refer to the same components) except that the joint body **200** further includes pressurizing or pressure control bladders **238** integrated into the joint body **200**. The pressure control bladders **238** may be integrally formed with the bladder sleeve **221**. Each pressure control bladder **238** defines a pocket, chamber or reservoir **238**A to receive a mass of a pressurizing material as described above. In use, the pressurizing material F is injected (e.g., using an injection tool I such as a syringe) into one or more of the pressure control bladders **238** to inflate the pressure control bladder and thereby displace and pressurize the gel **140** in the cavity **126**. The interfacial load between the joint body **200** and the cables **40**, **50** is thereby increased. In FIG. **7**, one of the pressure control bladders **238** is filled and the other pressure control bladder **238** is shown prior to filling. In some embodiments, the reservoirs **238**A are annular and generally concentric with the joint body axis A-A. In some embodiments, the joint body **200** and the pressure control bladders **238** are configured and used such that the pressurizing material F is retained and does not extend axially inwardly of the inner edge **134**B of the proximal stress cone layer **134**, so that the pressuring material F is electrostatically shielded by the stress cone layer **134**. An outer sleeve **90'** (shown in dashed lines in FIG. **7**) may be installed over the joint body **200** before or after injecting the pressuring material F so that the outer sleeve **90'** restrains or resists radially outward expansion of the joint body **200**. The outer sleeve **90'** may be any of the outer sleeves described above with regard to the outer sleeve **90** (including preformed rigid shells). It will be appreciated that further components such as the shield mesh **80**, clamps **82** and mastic **66** may also be installed over the joint body **200** but are omitted from FIG. **7** for the purpose of explanation.

Joint bodies according to embodiments of the invention can solve or mitigate a number of problems typically associated with known joint bodies such as thick-walled elastomeric joint bodies.

The inventive joint body can be provided with greater elasticity. The increase in elasticity can provide greater range taking ability. The greater elasticity presents lower recovery forces so that less force is required to expand and install the joint body on the connection. As a result, holdouts that are lighter, less expensive and easier to manufacture can be used. For example, a solid tubular holdout formed of a low friction material (as described above) can be used instead of a relatively expensive spiral holdout. Moreover, in accordance with some embodiments, the less tight fit of the joint body on the cables/connector and on the holdout can permit the joint body **100** to be pushed onto the connection as described above.

The integral Faraday cage layer **132** and stress cone layers **134** formed of electrically conductive elastomeric materials can serve to geometrically control the dielectric stress within the joint body **100** (primarily within the gel **140**). The outer screen layer **136** can serve as an earthed screen (e.g., grounded via the copper mesh **80**).

The higher elasticity of the joint body **100** also improves the electrical performance of the joint body by adapting more easily or conforming more closely to the shape of the prepared cable surface. This may be particularly important in case the terminal cut edge of the cable semiconductive layer **43**, **55** is relatively steep and not smoothed out, which is typically the case with EPR cables. The flexible or compliant "skin" (i.e., the bladder layer **120**) of the joint body **100** is beneficial in that it will follow the surface profile, of the cables **40**, **50** and the connector **60** more easily.

The higher elasticity of the joint body **100** can also improve the performance of the joint body **100** during thermal cycling of the connection in service because the joint body **100** can follow the expansion and contraction of the cables **40**, **50** as the conductor temperature changes.

With reference to FIGS. **8** and **9**, a joint body **300** according to further embodiments of the present invention is shown therein mounted in an expanded condition on a holdout **102** to form a pre-expanded joint body unit **301**. In FIG. **9**, the joint body **300** is shown partially contracted and mounted on the connection **15**. The joint body **300** can be used for the same purpose and in the same manner as the joint body **100** as discussed above, except as follows.

The joint body **100** includes a containment or bladder sleeve **321** defining a chamber or cavity **326** filled with a mass of an electrically insulating gel **340** (which may be the same as described above for the gel **140**). The joint body **300** has a longitudinal central joint body axis A-A and extends from an end **310**A to an opposing end **310**B along the axis A-A. Openings **312**A and **312**B are defined at the ends **310**A and **310**B and communicate with an axially extending through passage **316** defined by a tubular inner surface **314** of the joint body **300**. The joint body **300** has a tubular outer surface **315** opposite the inner surface **314**.

The bladder sleeve **321** is a tubular, integral, double-walled sleeve of unitary or single-piece construction. The walls of the sleeve **321** form an endless, continuous band. According to some embodiments and as illustrated, the bladder sleeve consists of a single bladder layer **320**. The bladder layer **320** extends axially from the end **310**A to the end **310**B. The bladder layer **320** has a tubular inner wall **322** and a tubular outer wall **324** joined at the ends **310**A, **310**B. The inner wall **322** forms the inner surface **314**. The outer wall **324** forms the outer surface **315**. The cavity **326** is defined as an annular or tubular cavity between the inner wall **322** and the outer wall **324**.

The bladder layer **320** can be formed of any suitable material. According to some embodiments, the bladder layer **320** is formed of an elastically expandable and electrically conductive or semiconductive material having a high permittivity and, in particular, a higher permittivity than the cable insulation layers **44**, **54** of the cables **40**, **50**. According to some embodiments, the bladder layer **320** is formed of a material having a dielectric constant in the range of from about 10 to 80. According to some embodiments, the bladder layer **320** if formed of a material having a volume resistivity in the range of from about 10^8 to 10^{14} Ohm-cm. According to some embodiments, the bladder layer **320** has a thickness T**3** (when installed) in the range of from about 0.10 to 0.25 inch. According to some embodiments, the bladder layer **320** is formed of an elastomeric material. According to some embodiments, the bladder layer **320** is formed of EPDM or silicone elastomer. According to some embodiments, the bladder layer **320** has a Modulus at 100 percent elongation (M**100**) in the range of from about 0.5 to 2.5 MPa.

The joint body **300** can be mounted on the connection **15** as shown in FIG. **9** for example. Additional components including the shield layer **80**, clamps **82**, mastic **66**, an outer sleeve **90** (of the varying types and constructions discussed above), and/or a pressurizing material may be installed about the joint body **300** in the same manner as described about with regard to the joint body **100**. In some embodiments, an electrical stress grading material **68** (e.g., a stress control mastic) is installed between and at the interfaces between the cables **40**, **50** and the connector **60** and the inner surface **314**.

When installed on the connection **15** as shown in FIG. **9**, the high permittivity material of the inner wall **322** serves as electrical stress grading material along the surfaces of the cables **40**, **50** to control electrical stress in the joint body **300** (primarily in the gel-filled cavity **326**). The high permittivity of the outer wall **324** serves as an electrostatic shield or screen (when suitably grounded) for the joint body **300**. An additional electrically conductive layer such as the copper mesh **80** (FIG. **6**) may be applied to the outer surface **315** to ensure that the earth potential is maintained all along the high permittivity outer wall **324**. The design of the joint body **300** can also provide dielectric stress grading for shield break points where the ends of cable screens can carry significant voltages against each other and against earth.

The joint body **300** may be installed on the connection **15** by pushing the joint body **300** off of the holdout **102** or pulling the holdout out of the joint body **300** as described above with regard to the joint body **100**.

According to some embodiments, the joint body **300** is rolled into position on the connection **15**. More particularly, the endless, continuous band bladder sleeve **321** is axially revolvable about itself so that portions thereof that constitute the inner wall **322** and the outer wall **324** at any given time may vary depending on the position of the bladder sleeve **321**. Likewise, the portions of the bladder sleeve **321** positioned at the ends **310**A, **310**B will change as the sleeve is revolved or rolled. That is, when the bladder sleeve **321** is revolved along its axis (e.g., as indicated by the arrows in FIG. **8**), the bladder sleeve **321** will evaginate (i.e., turn inside-out by eversion of the inner wall) at one end and invaginate (i.e., turn outside-in by inversion of the outer wall) at the other (opposite) end. Because the entire exposed surface (surfaces **314** and **315**) of the joint body **300** is formed of the high permittivity material, the final position of the joint body **300** is flexible and the stress grading feature is not position sensitive.

In order to facilitate rolling the joint body **300**, the gel **340** may be softer and/or have a greater liquid content than the gel **140**. According to some embodiments, the joint body **100** may be constructed for and installed by rolling the joint body **100** onto the connection.

With reference to FIG. **10**, a joint body **400** according to further embodiments of the present invention is shown therein mounted on the connection **15**. The joint body **400** can be used for the same purpose and in the same manner as the joint body **400** as discussed above, except as follows. The joint body **400** can likewise be provided as a pre-expanded unit on a holdout.

The joint body **400** differs from the joint body **300** in that the bladder sleeve **421** of the joint body **400** includes two intimate layers **423** and **425**. The layers **423** and **425** may be co-laminated or co-extruded, for example. The exterior layer **425** (which surrounds the interior layer **423** and forms the innermost and outermost surfaces **414** and **415**) has greater electrical conductivity than the interior layer **423** (i.e., the layer more proximate and defining the cavity **426** filled with the gel **440**). The interior layer **423** may be formed of an electrically insulating material as described above with regard to the bladder layer **120**. The exterior layer **425** may be formed of a high permittivity material as described above with regard to the bladder layer **320**.

According to further embodiments, a joint body having integral electrically conductive elements (e.g., the joint body **100** having layers **132**, **134**, **136**) may also be provided with a high permittivity outermost surface layer corresponding to the layer **425**.

According to some embodiments, the bladder sleeve of the joint body (e.g., the bladder sleeve **121**, **221**, **321**, or **421**) is formed of or includes a layer of a material (e.g., a metal foil or metalized layer) offering a low moisture absorption and a low moisture vapor transmission rate to protect the contained gel from moisture induced deterioration. Moisture ingress can also be avoided or inhibited by using a heat shrink wrap-around sleeve incorporating metallic foil as an outer protective sleeve.

While joint bodies as illustrated are mounted on holdouts in an expanded state, joint bodies according to some embodiments may be mounted on a support or holdout in a substantially non-expanded state and pushed therefrom onto the cable or connection, or may be provided without a support or holdout and pushed onto a cable or connection.

According to some embodiments, an electrical connector of a different type may be used in place of the shear bolt connector **60**. For example, the connector may be a compression, mechanical or any other suitable type of connector.

The foregoing is illustrative of the present invention and is not to be construed as limiting thereof. Although a few exemplary embodiments of this invention have been described, those skilled in the art will readily appreciate that many modifications are possible in the exemplary embodiments without materially departing from the teachings and advantages of this invention. Accordingly, all such modifications are intended to be included within the scope of this invention as defined in the claims. The invention is defined by the following claims, with equivalents of the claims to be included therein.

That which is claimed is:

1. A joint body for protecting an electrical cable connection including an electrical cable, the joint body comprising:

an expandable, elastomeric bladder sleeve defining a gel cavity and a cable passage to receive the electrical cable; and an electrically insulating gel disposed in the gel cavity and surrounding at least a portion of the cable passage;

wherein the joint body is configured to be installed on the connection such that the connection is disposed in the cable passage and is surrounded and electrically insulated by the gel;

wherein the bladder sleeve is a double-walled, tubular sleeve defining the gel cavity between the walls thereof; and

wherein the bladder sleeve includes:

an elastomeric, electrically insulating primary bladder layer defining the gel cavity;

an electrically conductive Faraday cage layer integral with the primary bladder layer and forming a part of an inner surface defining the cable passage; and

an electrically conductive stress cone layer integral with the primary bladder layer and forming a part of the inner surface.

2. The joint body of claim **1** wherein the bladder sleeve is radially elastically expandable.

3. The joint body of claim **1** further including an electrically conductive outer screen layer forming an outer surface of the joint body.

4. The joint body of claim **1** including a pressurizing bladder defining a pressurizing chamber sealed off from the gel cavity and adapted to receive a pressurizing material to pressurize the joint body.

5. The joint body of claim **1** wherein the gel is pre-sealed and cured in the gel cavity.

6. The joint body of claim **1** including a removable holdout mounted in the cable passage to maintain the bladder sleeve in an elastically radially expanded state, wherein the holdout is selectively removable from the joint body to permit the joint body to elastically radially contract about the connection.

7. The joint body of claim **1** wherein the bladder sleeve is formed of an elastomeric material selected from the group consisting of EPDM elastomer and silicone elastomer.

8. The joint body of claim **1** wherein the gel is a gel selected from the group consisting of silicone-based gel and hydrocarbon oil-based gel.

9. The joint body of claim **1** wherein the Faraday cage layer and the stress cone layer are embedded in the primary bladder layer.

10. The joint body of claim **1** wherein the primary bladder layer forms a part of the inner surface.

11. A method of protecting an electrical cable connection including an electrical cable, the method comprising:

providing a joint body including:

an expandable, elastomeric bladder sleeve defining a gel cavity and a cable passage to receive the electrical cable; and

an electrically insulating gel disposed in the gel cavity and surrounding at least a portion of the cable passage; and

installing the joint body on the connection such that the connection is disposed in the cable passage and is surrounded and electrically insulated by the gel;

wherein the bladder sleeve is a double-walled, tubular sleeve defining the gel cavity between the walls thereof; and

wherein the bladder sleeve includes:

an elastomeric, electrically insulating primary bladder layer defining the gel cavity;

an electrically conductive Faraday cage layer integral with the primary bladder layer and forming a part of an inner surface defining the cable passage; and

an electrically conductive stress cone layer integral with the primary bladder layer and forming a part of the inner surface.

12. The method of claim **11** wherein installing the joint body on the connection includes:

providing a pre-expanded joint body unit including the joint body mounted on a holdout in an elastically radially expanded state;

positioning the pre-expanded joint body unit adjacent the connection; and thereafter

removing the holdout from the joint body or removing the joint body from the holdout to permit the joint body to elastically radially contract onto the connection.

13. The method of claim **11** wherein:

the joint body includes a pressurizing bladder defining a pressurizing chamber sealed off from the gel cavity; and

the method further includes, after installing the joint body on the connection, injecting a pressurizing material into the pressurizing chamber to pressurize the joint body.

14. The method of claim **11** further including installing an outer sleeve around the joint body on the connection such that the outer sleeve radially constrains the joint body.

15. The method of claim **14** wherein the outer sleeve applies a persistent radially compressive load to the joint body.

16. The method of claim **11** wherein the gel is sealed and cured within the gel cavity prior to the step of installing the joint body on the connection.

17. The method of claim **11** wherein the Faraday cage layer and the stress cone layer are embedded in the primary bladder layer.

18. The method of claim **11** wherein the primary bladder layer forms a part of the inner surface.

19. A protected connection assembly comprising:

an electrical cable connection including an electrical cable; and

a joint body including:

an expandable, elastomeric bladder sleeve defining a gel cavity and a cable passage to receive the electrical cable; and

an electrically insulating gel disposed in the gel cavity and surrounding at least a portion of the cable passage;

wherein the joint body as installed on the connection such that the connection is disposed in the cable passage and is surrounded and electrically insulated by the gel;

wherein the bladder sleeve is a double-walled, tubular sleeve defining the gel cavity between the walls thereof; and

wherein the bladder sleeve includes:

an elastomeric, electrically insulating primary bladder layer defining the gel cavity;

an electrically conductive Faraday cage layer integral with the primary bladder layer and forming a part of an inner surface defining the cable passage; and

an electrically conductive stress cone layer integral with the primary bladder layer and forming a part of the inner surface.

20. The protected connection assembly of claim **19** wherein the connection is a splice connection including an electrical connector and a pair of electrical cables electrically and mechanically coupled by the connector.

21. The protected connection assembly of claim **19** wherein the Faraday cage layer and the stress cone layer are embedded in the primary bladder layer.

22. The protected connection assembly of claim **19** wherein the primary bladder layer forms a part of the inner surface.

23. A method of protecting an electrical cable connection including an electrical cable, the method comprising:

providing a joint body including:

an expandable, elastomeric bladder sleeve defining a gel cavity and a cable passage to receive the electrical cable; and

an electrically insulating gel disposed in the gel cavity and surrounding at least a portion of the cable passage; and

installing the joint body on the connection such that the connection is disposed in the cable passage and is surrounded and electrically insulated by the gel;

wherein the bladder sleeve is a double-walled, tubular sleeve defining the gel cavity between the walls thereof; and

wherein:

the joint body includes a pressurizing bladder defining a pressurizing chamber sealed off from the gel cavity; and

the method further includes, after installing the joint body on the connection, injecting a pressurizing material into the pressurizing chamber to pressurize the joint body.

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